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VIII. *An Account of the urinary organs and urine of two species of the genus Rana.* By JOHN DAVY, M. D. F. R. S.

Read January 18, 1821.

IN a letter to Sir HUMPHRY DAVY, which was written almost two years ago, and which I understand has been honoured with a place in the Transactions of the Royal Society, I have described the kidneys of many different animals of the class Amphibia, and have shown, with one exception not there insisted on, that their urinary secretion is very similar, consisting almost entirely of uric acid.

The exception which occurred to me, was in the case of frogs, on whose urinary organs and secretion I have had an opportunity, lately, of making fresh and more minute enquiry, the results of which I beg leave to communicate.

I shall first relate the observations I have collected on the urinary organs of these animals, and then describe the experiments I have made to determine the nature of their urine.

The examination I have engaged in, has been limited to two species, the bull-frog (*Rana taurina*, Cuv.) and the brown-toad (*Bufo fuscus*, Laurenti) which are both very common in this neighbourhood; the former inhabiting the lake of Colombo, where it occasionally grows to a great size; and the latter frequenting houses, and abounding by night in the streets of the Pettah.

The kidneys of the bull-frog are apart, one on each side of

the spine ; comparatively pretty large ; very much lobulated ; of a bright red colour, and rather tender.

The ureters do not terminate in the bladder, but in the rectum, by two soft papillæ projecting a little, and situated between the orifice of the bladder and the anus, nearer the former than the latter.

The bladder of urine is of large dimensions ; nearly globular ; semi-transparent, and yet pretty strong and contractile. It opens into the rectum, a few lines behind the anus, by a large orifice, very well adapted to receive the urine, as it flows from the ureters, when the anus is closed, as it usually is, by its powerful sphincter muscle.

The urinary organs of the brown-toad resemble, in most respects, those of the green-frog. In two specimens, out of many that I have dissected, I have found the kidneys incorporated at their upper ends. The ureters have the same termination nearly. The bladder of urine appears to be double ; when distended fully with air, it resembles two oval bags ; the compartments communicate freely just above the symphysis pubis, to which they are firmly attached ; and they have but one orifice into the rectum, which is as well suited as in the former instance, for the reception of the urine as it flows into the rectum.

The urine of the bull-frog, taken from the bladder immediately after the death of the animal, varies a little in its appearance in different instances ; and, of course varies considerably in quantity, the bladder being sometimes full almost to distension, and at other times quite empty. The following is a description of a quantity of urine amounting to 300 grains which was collected from thirty-six frogs of different sizes :

It looked like water, and was almost transparent. It was insipid, but not without smell; it emitted an odour not unlike that of serum of blood. It was of sp. grav. 1003.

It is obvious, that with its appearance its chemical nature must also vary. The urine, the physical properties of which I have described, had no effect on litmus or turmeric paper; slowly evaporated, it afforded a minute quantity of brownish extract, which had the smell of urea. It deliquesces when exposed to the air; and when decomposed by heat in a small glass tube, it yielded a little amber-coloured oily fluid and strong ammoniacal fumes; and a coal remained, in which I discovered a large proportion of common salt and a little phosphate of lime.

Another specimen of the urine of these frogs, which I examined, was rather more dilute. I detected in it a minute portion of common salt and of phosphate of lime, without any traces of urea.

The urine of the brown-toad is pretty uniform in different instances in its appearance; and, judging from the experiments I have made, in its nature also. From eighty-four toads, caught in the streets of the Pettah, 732 grains of urine were collected. Examined when quite fresh, it was nearly transparent, and would have been perfectly so, but for a few minute flocculi suspended in it. It was of a pretty bright straw yellow, very like healthy human urine in appearance, with the peculiar smell of human urine, and nearly the same taste in a slight degree. It was of sp. grav. 1008.

It did not alter litmus or turmeric paper. Nitrate of silver dropt into it, produced a very copious precipitate of luna cornea. A solution of corrosive sublimate occasioned a minute

flocculent precipitate. Neutral acetate of lead, a copious white precipitate. *Aqua ammoniæ* had no effect. Oxalate of ammonia produced a slight cloudiness; and a faint cloudiness was produced by muriate of barytes, which did not disappear on the addition of a drop of nitric acid. A portion of this urine, slowly evaporated, afforded a brown extract, with a strong urinous smell. To a moiety of this extract of a syrupy consistence, a drop of nitric acid was added; the effect produced was just the same as if human urine had been the subject of the experiment; a crystalline compound was immediately formed, which I could not hesitate in pronouncing nitrate of urea. The other moiety, decomposed by heat in a close glass tube, afforded a considerable quantity of yellow oily fluid, strongly impregnated with subcarbonate of ammonia, and a residual coal, from which I obtained a large proportion of common salt and a little phosphate of lime, and slight traces of a fixed alkaline phosphate.

Another portion of this urine was set aside to undergo spontaneous decomposition. It has been kept now eight days. It has become slightly turbid, and has acquired a distinct, though not strong ammoniacal odour, mixed with another kind of odour, not unlike that of cabbage.

The conclusions to be drawn from the results of these experiments scarcely need to be pointed out: it is pretty evident, now, that the urine of the bull-frog and of the brown-toad contains urea, and the latter rather abundantly. Reasoning from analogy, the probability is, that the urine of frogs and toads in general is of a similar nature, and altogether different from that of the other amphibia.

It is seldom that any very abrupt transitions are to be

observed in nature : the urinary organs of the turtle and tortoise, seem to be a connecting link between those of the animals in question, and those of serpents and lizards.

Perhaps additional facts are not required to prove, that the secretion of the kidneys of animals depends more on the intimate and invisible structure of these organs, than on the kind of food the animals consume ; were such facts wanting, there would be no difficulty in furnishing them. How different is the urine of the brown-toad and that of any species of small lizards ! yet flies are the favourite and common diet of both animals. Other remarkable instances might be mentioned, of similarity of diet and difference of urinary secretion ; and, *vice versa*, instances might be afforded of difference of diet and similarity of urine : I will mention one only ; it is that of parrots and snakes ; their urine, as I have found, being much the same, consisting chiefly of uric acid, though their diet is altogether different, the birds feeding entirely on vegetable matter, and the reptiles entirely on animal matter. But let me not be supposed to maintain that the urinary secretion depends entirely on the organ, quite independent of the nature of the food or of the blood, from which the elements of the urine are derived. It appears to be pretty satisfactorily proved, that, *cæteris paribus*, there is a certain relation between the nature of the food and of the urine. Whilst this has been generally admitted, the relation between the organ and the secretion has been less insisted on, though perhaps not less curious and deserving of attention.

I have hitherto made no allusion to the difference of opinion amongst comparative anatomists, on the subject of the urinary organs of the frog, whether it has, or has not, an urinary

bladder ; nor do I propose now, more than barely to allude to it. I flatter myself, that the analysis I have given of the contents of the bladder of the frog and toad, not to mention the anatomical observations detailed, will satisfy the sceptical, that the bladder of these animals is really a bladder of urine, according to the opinion long since advanced by M. CUVIER.

Colombo, Ceylon, January 28, 1819.